REMARKS/ARGUMENTS

Claims 1-25 are pending in this application, with claim 1 being an independent claim and all remaining claims ultimately depending from claim 1.

Claim 1 is amended herein to state that the anode comprises mesoporous titanium dioxide or mesoporous lithium titanate. Support for this amendment can be found in original claim 2. Claim 1 is also amended to recite a cathode formed of a mesoporous material selected from the group consisting of nickel, a nickel oxide, a nickel hydroxide, a nickel oxy-hydroxide and combinations thereof. Support for this amendment can be found in original claims 4-7 and page 3, line 24, through page 4, line 2, of the as-filed specification.

Claims 2, 4-7 and are hereby canceled. Claims 3, 8-11 and 13-14 are amended to depend from amended claim 1 instead of canceled claims 2 and 4. It is believed no new matter is added by these amendments.

<u>Rejections under 35 USC 103</u>

A. Sugnaux in combination with Anderson

The Examiner rejected claims 1-16 and 19-25 under 35 U.S.C. 103(a) as being obvious over Sugnaux (U.S. Published Application 2004/0131934) in view of Anderson (U.S. Patent 5,963,417). In light of the amendments made herein, Applicants respectfully traverse.

Claim 1 as presently amended is directed toward an electrochemical cell having a cathode, an anode and an electrolyte, where the anode comprises mesoporous titanium dioxide or a mesoporous lithium titanate; and the electrolyte comprises an aqueous solution containing lithium and hydroxide ions. Additionally, claim 1 recites that the cathode is formed from a mesoporous material selected from the group consisting of nickel, a nickel oxide, a nickel hydroxide, a nickel oxy-hydroxide and combinations thereof.

Sugnaux discloses an electrochemical cell comprising a cathode, an anode and a non-aqueous electrolyte solution containing lithium. The Examiner noted that Sugnaux fails to disclose an aqueous electrolyte as required by the claims and turns to Anderson to overcome this deficiency. Anderson discloses an electrochemical cell comprising a cathode, an anode and an aqueous electrolyte containing lithium and hydroxide ions. The Examiner concluded that it would have been obvious to one ordinarily skilled in the art to substitute the non-aqueous electrolyte of Sugnaux with the aqueous electrolyte of Anderson to arrive at the presently claimed invention because such a combination is a mere substitution requiring only routine skill in the art. Applicants respectfully disagree.

With regards to previous claim 2, which stated that the anode comprises mesoporous titanium dioxide or a mesoporous lithium titanate, now incorporated in claim 1, the Examiner asserted that Sugnaux further discloses that the titanium dioxide or lithium titanate is mesoporous.

With regards to previous claims 6 and 7, which stated that the mesoporous material of the cathode comprises nickel, a nickel oxide, a nickel hydroxide, or a nickel oxy-hydroxide, now incorporated in claim 1, the Examiner asserted that Anderson discloses such mesoporous nickel compounds.

Remaining claims 3 and 8-25 ultimately depend from claim 1 and include limitations generally related to the physical properties of the materials, such as pore diameter, pore density, cubic and hexagonal arrangement of pores, and film thickness. Of these claims, the Examiner rejected claims 3, 8-16 and 19-25 as containing limitations disclosed in Sugnaux or Anderson, or containing general conditions that the Examiner asserted would have been discoverable through routine skill in the art in light of Sugnaux and Anderson.

In light of the amendments made herein, Applicants respectfully disagree with the Examiner and assert that it would not have been obvious to combine Sugnaux with Anderson to arrive at the present claims because the cited references either teach against such a combination or do not provide a reasonable expectation that such a combination would be successful.

As discussed on pages 1 and 2 of the as-filed specification, titanium dioxide is well known as a negative electrode (anode) for lithium-ion batteries in which it is combined with a highly oxidizing positive electrode (cathode) such as Li_xCoO_2. Usually this system is used with a non-aqueous electrolyte. This is because titanium dioxide has a reduction potential which is extremely close to that of hydrogen evolution from the aqueous electrolyte. The current invention has, however, surprisingly found that the use of a cathode formed of a mesoporous nickel, a nickel oxide, a nickel hydroxide, a nickel oxy-hydroxide or a combination of two or more of these with an aqueous electrolyte and an anode comprising mesoporous titanium dioxide or a mesoporous lithium titanate, produces an extremely advantageous electrochemical cell for use as a lithium-ion battery or a supercapacitor. None of the cited prior art documents discloses the unexpected advantages of such a cell.

Sugnaux relates to electrochemical cells employing mesoporous titania anodes with nonaqueous organic electrolyte. As acknowledged by the Examiner, Sugnaux fails to explicitly disclose an electrolyte comprising an aqueous solution which contains lithium and hydroxide. Additionally Sugnaux fails to specifically teach that the cathode is formed of a mesoporous material selected from nickel, a nickel oxide, a nickel hydroxide, a nickel oxy-hydroxide or a combination or any two or more of these. Rather paragraph [0049] of Sugnaux provides a broad teaching that:

> [0049] The electrode active material of the electrode according to the invention is preferably selected from an oxide, chalcogenide, hydroxide, oxyhydroxide, oxo-acid, oxohydride or thiocyanic acid of a non-transition or transition metal, or its lithiated or partially lithiated form selected from the group consisting of Group IB,

IIA, IIB, IIIA, IVA, IVB, VA, VB, VIIB, VIIB and VIII elements of the Periodic Table of Elements, and blends thereof.

The examples of Sugnaux disclose mesoporous $TiO_2/LiCoO_2$ as negative and positive electrodes respectively (Example 5), as well as the use of a mesoporous multilayer system having TiO_2/Al_2O_3 as the anode with $LiCoO_2$ as the cathode (Example 7). There is therefore nothing in Sugnaux which leads the skilled person to an electrochemical cell comprising a cathode comprising mesoporous nickel compounds as presently claimed. Rather in light of the broad disclosure at paragraph [0049], one skilled in the art would follow the examples of Sugnaux which encourage the use of a lithiated cobalt oxide. As discussed above, this is the cathode conventionally used with a titanium dioxide anode.

The Examiner therefore turns to Anderson to cure these defects. Anderson is concerned with providing an electrochemical capacitor that includes an inexpensive porous electrode formed of irregularly or randomly packed nano-sized transition metal oxide or metal grains (column 4, lines 3-5). The preferred electrode system is nickel/nickel oxide. There is, however, no disclosure of an anode comprising mesoporous titanium dioxide or a mesoporous lithium titanate in combination with a cathode formed of a mesoporous nickel, a nickel oxide, a nickel hydroxide, a nickel oxy-hydroxide or a combination of any two of these, and an aqueous electrolyte as required by Claim 1.

For one skilled in the art to arrive at the currently claimed invention from Sugnaux and Anderson, they would have to select the following features out of the many different possible combinations:

- an anode comprising mesoporous titanium dioxide or a mesoporous lithium titanate;

- an electrolyte comprising an aqueous solution containing lithium and hydroxide ions; and

- a cathode formed of a mesoporous material selected from the group consisting of nickel, a nickel oxide, a nickel hydroxide, a nickel oxy-hydroxide or a combination of any two or more of these.

Without using hindsight analysis, however, Applicants submit that neither cited reference provides one skilled in the art with any suggestion or motivation to select and combine these specific elements out of all of the possible combinations available.

Firstly, Anderson does not encourage one skilled in the art to use an anode comprising mesoporous titanium dioxide or a mesoporous lithium titanate in combination with an aqueous electrolyte and a cathode as defined in Claim 1. Rather column 7, line 46 of this document teaches that titanium oxide is "less attractive than other oxides investigated". This implies that the titanium oxide is a lesser alternative for the anode compared to the nickel oxide used in Anderson. This suggests away from using titanium dioxide in combination with nickel oxide.

Moreover, column 7, lines 48-50, teaches that the "*performance of titanium dioxide as an electrochemical capacitor could be improved by employing lithium intercalation and organic electrolytes*". Column 10, lines 17-20 then teaches that a non-aqueous "*Li+ containing ionic electrolyte...is preferred in a nickel oxide/nickel system*". Thus even if the skilled person were to use titanium dioxide as taught in Sugnaux with a nickel oxide electrode of Anderson, they are explicitly taught to use a Li+ containing organic, ionic electrolyte. This is in contrast to the aqueous electrolyte used in the present case.

Anderson also discloses that its electrode active materials have a high surface area which results from the random packing of the grains (column 4, lines 10-13), and that its electrodes are formed by a sol-gel method (see Example 1), not by an electrochemical or vacuum method. The sol-gel method involves coating the nickel oxide sol onto a nickel grid by dipping and then firing at a temperature above 200°C in air. In contrast, Sugnaux is concerned with an electrode active material in the form of a mesoporous framework structure (see for example paragraphs [0017], [0051], [0057] and [0068]). This is obtained by, for example, casting a colloidal dispersion of the solid particles on a conductive film serving as a current collector (paragraph [0074]).

Sugnaux emphasizes in paragraphs [0075], [0076] and [0083] that the main advantage of the invention described therein is that the electrode is produced under ambient conditions, without the need for heating. This allows a wide variety of materials to be used.

Thus, while Anderson may disclose the use of nickel oxides for an electrode, Anderson does not disclose that the nickel oxide is mesoporous. If anything, the sol-gel preparation method used in Anderson suggest against a mesoporous structure, and particularly against the uniform porosity limitations in dependent claims 3, 8-14 and 22-25. There are therefore fundamental differences between both the molecular structure of the electrodes and the preparation methods used in Sugnaux and Anderson.

Because Anderson teaches that titanium oxide is a less preferred material for the anode, and that an organic electrolyte should be used with titanium oxide or a nickel oxide/nickel system, and that their nickel oxide electrodes are not mesoporous, it is believed that it would not be obvious to combine Anderson with Sugnaux to arrive at the electrochemical cell as presently claimed in Claim 1. Absent any suggestion in either reference of such a combination or the advantages associated therewith, Applicants submit that these differences would lead one skilled in the art away from combining these two documents. Therefore, it is believed that this rejection should be withdrawn. Because claims 3, 8-16 and 19-21 ultimately depend from claim 1, it is requested that these rejections also be withdrawn.

B. Zaghib in combination with Anderson

The Examiner also rejected claims 1 and 17-21 under 35 U.S.C. 103(a) as being obvious over Zaghib (U.S. Published Application 2004/00202934) in view of Anderson. In light of the amendments made herein, Applicants respectfully traverse.

Zaghib discloses an electrochemical cell comprising a cathode, an anode and a non-aqueous electrolyte comprising lithium, where the anode comprises titanium oxide

or lithium titanate. The Examiner asserted that it would have been obvious to one skilled in the art to substitute the non-aqueous electrolyte of Zaghib with the aqueous electrolyte disclosed in Anderson because such a combination is a mere substitution requiring only routine skill in the art. Applicants respectfully disagree.

Zaghib also fails to disclose an electrochemical cell comprising a cathode, an anode and an electrolyte as required by presently amended Claim 1. Rather the cathode/anode of its electrochemical generator is of the $Li_4Ti_5O_{12}$ type and/or of the $Li_{(4-\alpha)}Z_\alpha Ti_5O_{12}$ type and/or of the $Li_4Z_\beta Ti_{(5-\beta)}O_{12}$ type or mixtures thereof, or of the $LiFePO_4$, $LiCoO_2$, $LiCoPO_4$, $LiMn_2O_4$ and/or $LiNiO_2$ type or mixtures thereof (see paragraphs [100]-[101]). The only electrolytes disclosed and exemplified in Zaghib are non-aqueous electrolytes. Example 4 for instance, involves the use of a tetraethyl-sulfoneamine ethylene carbonate type solvent with lithium triflouromethanesulfonimide salt. Thus, there is no suggestion or motivation to replace the non-aqueous electrolyte of Zaghib with the aqueous electrolyte of Anderson. As discussed above, Anderson also discloses that titanium oxide is a less desirable material and that an organic Li+ ionic electrolyte should be used with titanium dioxide or nickel oxide electrodes.

Zaghib also fails to disclose that the cathode/anode material is mesoporous. In light of the sol-gel preparation methods used in Anderson, there is no disclosure in either document to form mesoporous nickel electrodes. Thus even if one skilled in the art were to combine the teachings of Anderson and Zaghib, the combination would not arrive at the currently claimed invention. Accordingly, it is respectfully requested that these obviousness rejections also be withdrawn.

C. Bekesh in combination with Anderson

The Examiner also rejected claims 1, 4-10, 13, 19 and 21-25 under 35 U.S.C. 103(a) as being obvious over Bekesh (RU 2170467C1) in view of Anderson. In light of the amendments made herein, Applicants respectfully traverse.

Bekesh discloses the addition of particles of any one of a group of oxide materials, including titanium dioxide, to the activated carbon type electrodes of a double layer capacitor. The effect of these additional particles is to reduce internal resistance and enhance specific power in the device. While the nature of the electrolyte is not directly disclosed, the oxide additives are described as "moisture-absorbing material particles", the reference to moisture denoting a water-based aqueous electrolyte. Bekesh fails, however, to disclose a mesoporous cathode as defined in presently amended Claim 1. As discussed above, the sol-gel preparation methods used in Anderson would not produce a mesoporous electrode. Thus, neither reference teaches or discloses the mesoporous limitations of the presently claimed invention. Accordingly, even if the references were combined, they would not result in each and every limitation of the present claims.

In addition, it is noted that the Examiner believes one skilled in the art would add titanium dioxide as taught in Bekesh to the nickel oxide electrodes of Anderson. Applicants respectfully disagree.

Activated carbon materials used in double layer capacitors are inherently hydrophobic. This is not a problem when organic electrolytes are used since these are also hydrophobic. However, aqueous electrolytes have difficultly being fully absorbed into the electrode and difficulty "wetting" the surface of the hydrophobic activated carbon. This results in increased internal resistance and reduced power. A strategy to overcome this problem is to add hydrophilic materials (such as oxides) to the activated carbon. The "moisture-absorbing" properties of these materials help draw the water-based electrolyte into the electrode to more fully wet the activated carbon. This results in reduced resistance and therefore increased power.

Contrary to the Examiner's assertion, Applicants submit that the skilled person would not add the titanium dioxide of Bekesh to the nickel oxide electrodes of Anderson, since nickel oxide electrodes (which already have good conductivity as stated in the

abstract of Anderson) are inherently hydrophilic and so would not benefit from such an addition. Accordingly, one skilled in the art would have no motivation to combine the additive of Bekesh and the capacitor of Anderson to arrive at the presently claimed invention.

Because the combination of these references would not result in each and every limitation of the present claims, and because it is believed there would be no motivation to combined these references, it is requested that this rejection also be withdrawn.

Conclusion

In view of the foregoing, it is submitted that this case is in condition for allowance, and passage to issuance is respectfully requested. If there are further issues related to patentability, the courtesy of a telephone interview is requested, and the Examiner is invited to call to arrange a mutually convenient time.

This response is accompanied by a Request for Continued Examination and fees in the amount of $455. However, if this amount is incorrect, please charge any deficiency to Deposit Account No. 07-1969.

Respectfully submitted,

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